SPEED-TIME-FALLING OBJECTS

1 **(a)** A stone falls from the top of a building and hits the ground at a speed of 32 m/s.
The air resistance-force on the stone is very small and may be neglected.

(i) Calculate the time of fall.

time = ...

(ii) On Fig. 1.1, draw the speed-time graph for the falling stone.

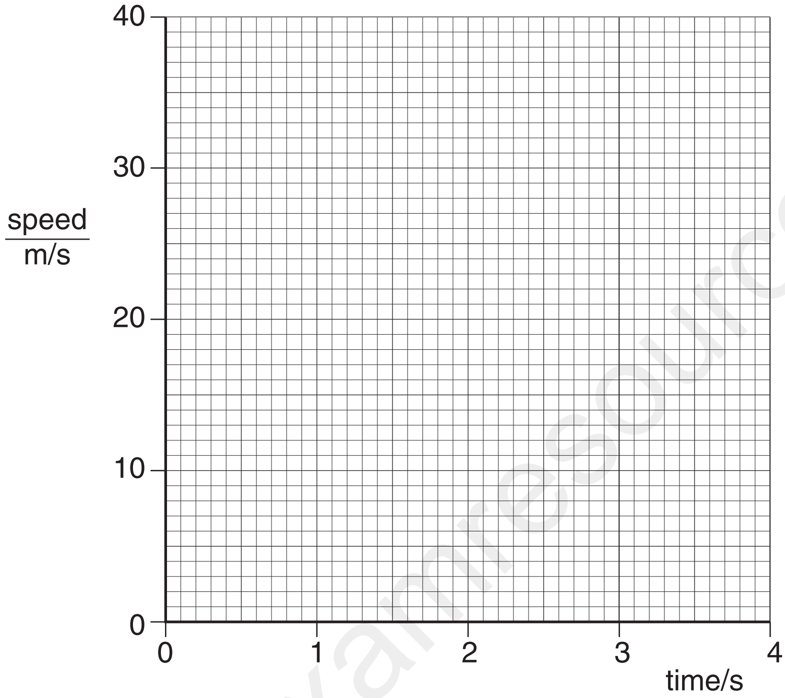

Fig. 1.1

(iii) The weight of the stone is 24 N.
Calculate the mass of the stone.

mass = ...
[5]

(b) A student used a suitable measuring cylinder and a spring balance to find the density of a sample of the stone.

(i) Describe how the measuring cylinder is used, and state the readings that are taken.

....

....

....

....

(ii) Describe how the spring balance is used, and state the reading that is taken.

....

....

(iii) Write down an equation from which the density of the stone is calculated.

....

(iv) The student then wishes to find the density of cork. Suggest how the apparatus and the method would need to be changed.

....

....

....

[6]

(a)	**(i)**	t = v/g or 32/10 = 3.2 s	C1 A1	
	(ii)	straight line starting at zero, inclined line joining 0,0 and 3.2, 32, accept c.f. from time **(i)**	C1 A1	
	(iii)	2.4 kg	A1	[5]
(b)	**(i)**	take volume of water before use (totally) immerse stone and take new volume (Not clearly measured before and after C1)	B1 B1	
	(ii)	hang rock from balance and take reading	B1	
	(iii)	density = mass/volume	B1	
	(iv)	need to tie "sinker" or cork or press cork down need volume with sinker then volume with sinker and cork or just completely submerge cork	B1 B1	[6]

[Total: 11]

2 Fig. 1.1 shows the path of one drop of water in the jet from a powerful hose.

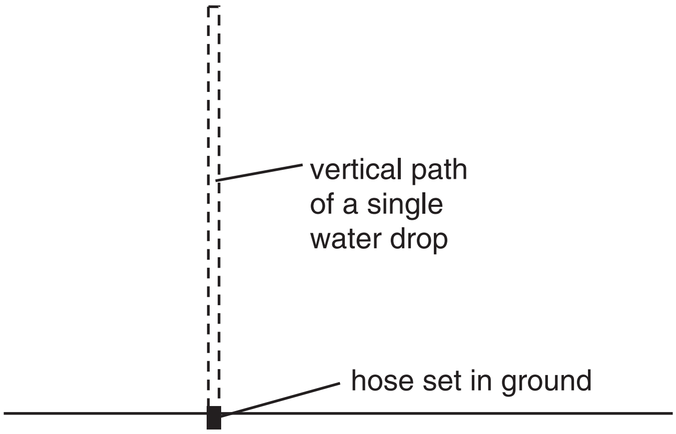

Fig. 1.1

Fig. 1.2 is a graph of speed against time for the water drop shown in Fig. 1.1.

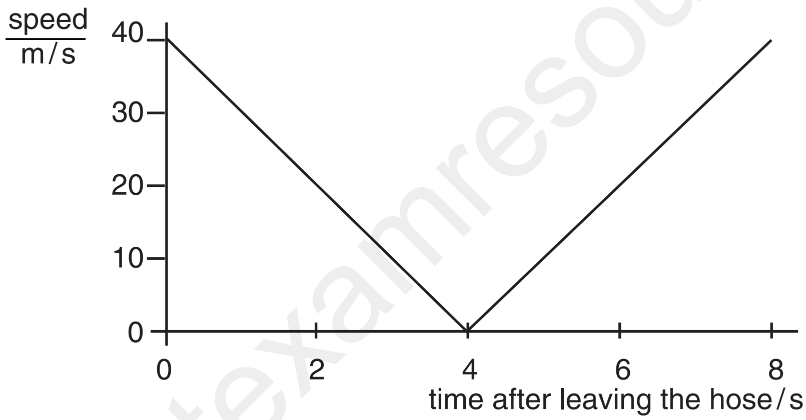

Fig. 1.2

(a) Describe the movement of the water drop in the first 4 s after leaving the hose.

....

....

....[2]

(b) Use Fig. 1.2 to find

(i) the speed of the water leaving the hose,

speed = …………………...

(ii) the time when the speed of the water is least.

time = ……………………..

[2]

(c) Use values from Fig. 1.2 to calculate the acceleration of the drop as it falls back towards the ground. Show your working.

acceleration = ……………………...[3]

(d) Calculate the greatest distance above the ground reached by the drop.

distance = ……………………...[3]

(a)	deceleration/slows down/speed reduces	**1**	
	deceleration uniform/comes to rest at 4 s	**1**	**2**
(b) (i)	40 (m/s)	**1**	
(ii)	4 (s)	**1**	**2**
(c)	speed falls from 0 to 40 m/s in 4 s	**1**	
	acceleration = change in speed/time taken or 40(m/s)/4(s)	**1**	
	acceleration = 10 m/s^2	**1**	**3**
(d)	distance = average speed x time or area of triangle under graph	**1**	
	= 20 x 4 or 2 x 40	**1**	
	= 80 m	**1**	**3**
			(10)

3 Fig. 1.1 shows the axes for a speed-time graph.

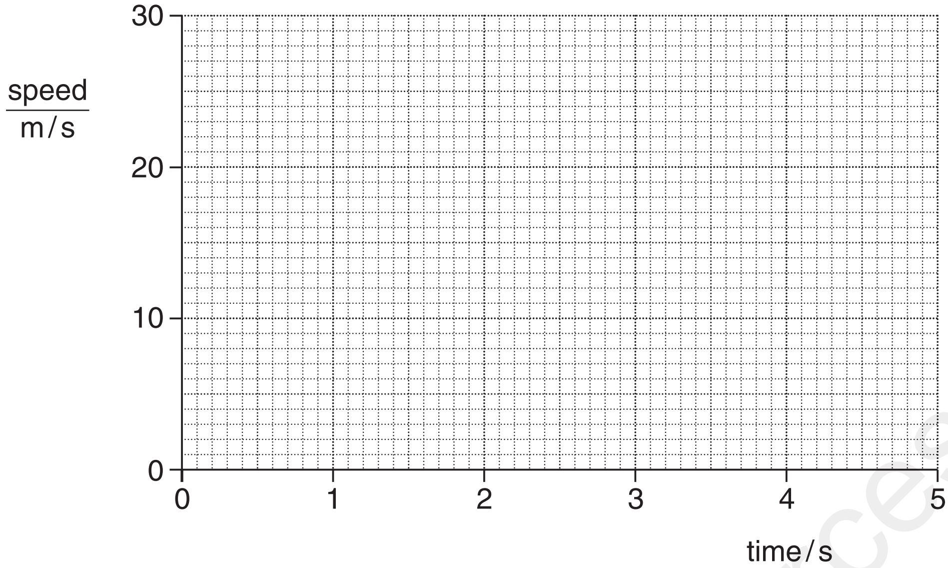

Fig. 1.1

(a) An object A falls freely from rest with the acceleration due to gravity (g = 10 m/s^2). It is not affected by air resistance.

On Fig. 1.1, draw the graph of the motion of object A. [1]

(b) Using your graph, or an alternative method, calculate the distance fallen in the first 2 s by object A in part **(a)**.

distance fallen = ... [2]

(c) A second object B falls through the air from rest, but is affected by air resistance. It reaches a terminal velocity of 14 m/s.

On Fig. 1.1, draw a possible graph for object B, including the region where it is travelling at terminal velocity. [1]

(d) **(i)** Suggest a possible difference between objects A and B that could lead to B reaching a terminal velocity.

....

....

.... [1]

(ii) Explain, in terms of the forces on B, why B reaches a terminal velocity.

....

....

....

....

.... [2]

(e) Object A experiences a gravitational force of 2.0 N.

(i) State the value of the weight of A.

weight = ... [1]

(ii) Calculate the mass of A.

mass = ... [1]

(f) Object A is floating in equilibrium on a liquid.

State the value of the upward force of the liquid on A.

upward force = ... [1]

[Total: 10]

(a)	straight line through origin and reaching (or would reach) 30m/s after 3s	B1
(b)	average speed × time or area under graph or $s = ut + ½at^2$ or ½b × h	C1
	20 m c.a.o.	A1
(c)	line, all below first line and horizontal at 14m/s (±½ small square) NOTE: "knee" of line need not be curved	B1
(d) (i)	any intelligent attempt e.g. effect of air resistance, B larger area than A, B smaller mass/weight than A	B1
(ii)	(eventually) upward force on B = downward force or equivalent.	B1
	no more acceleration or constant speed NOT terminal velocity	B1
(e) (i)	2.0 N or 2 N	B1
(ii)	0.2 kg or 200 g	B1
(f)	2 N or 2.0 N or candidate's **(e)(i)**	B1
		[10]